AgMIP The Agricultural Model Intercomparison and Improvement Project

AgMIP Town Hall



Alex Ruane and Cynthia Rosenzweig, NASA GISS
Page Kyle, PNNL; Bruno Basso, Michigan State University,
Jonathan Winter, Dartmouth College, and Senthold Asseng, University of Florida

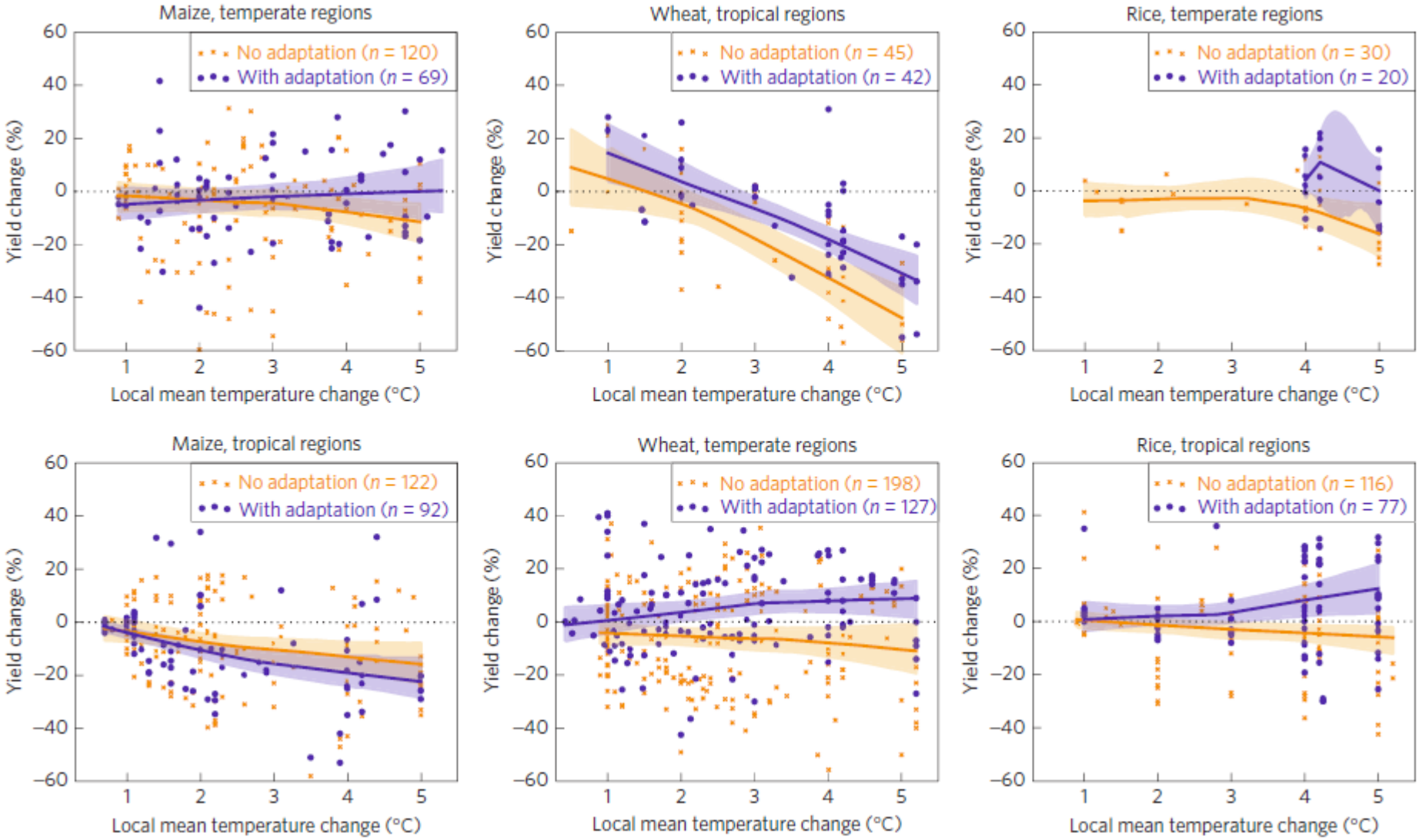
AGU 2015 Fall Meeting
December 15, 2014

UKaid from the Department for International Development
USDA
USAID United States Agency International Development
CGIAR Research Program on Climate Change, Agriculture and Food Security
CCAFS
NASA

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Crop Responses are Not Clear

(Meta-analysis by Challinor et al., Nature Climate Change and IPCC WG2)



Difficult to make sense out of incredibly diverse studies



The Agricultural Model Intercomparison and Improvement Project (AgMIP)

AgMIP The Agricultural Model Intercomparison and Improvement Project

Worldwide Science Community



1st Global Oct 2010



2nd Global Oct 2011



4th Global Oct 2013



5th Global Feb 2015



Sub-Saharan Africa #3



South Asia #3



3rd Global Oct 2012

Phase 2 Mission 2015-2020

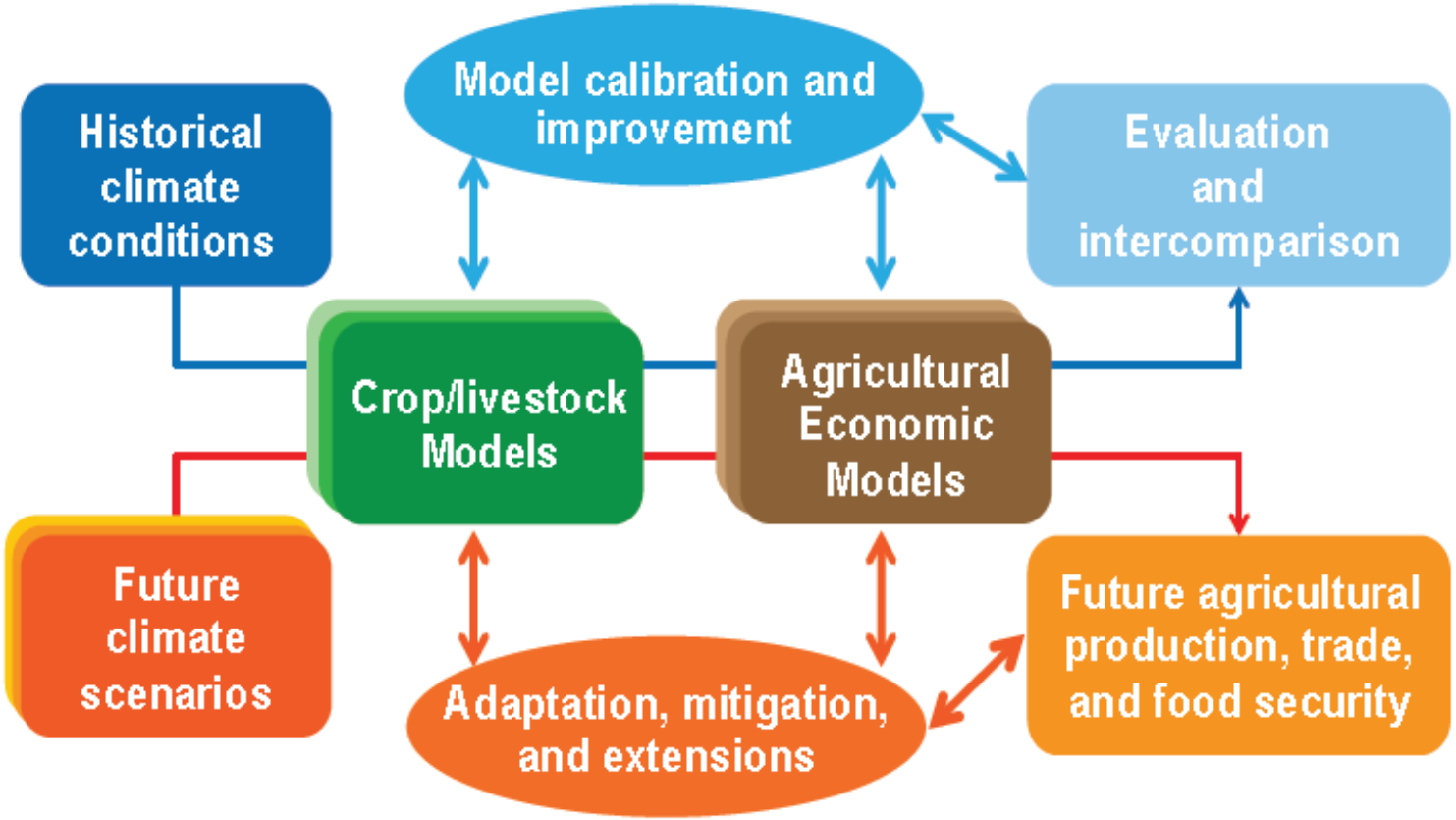
Provide effective **science-based agricultural decision-making models and assessments** of **climate variability and change** and **sustainable farming systems** to achieve **local-to-global food security**



Arusha, Tanzania

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AgMIP Approach Enables *Testing* of Farm and Policy Strategies



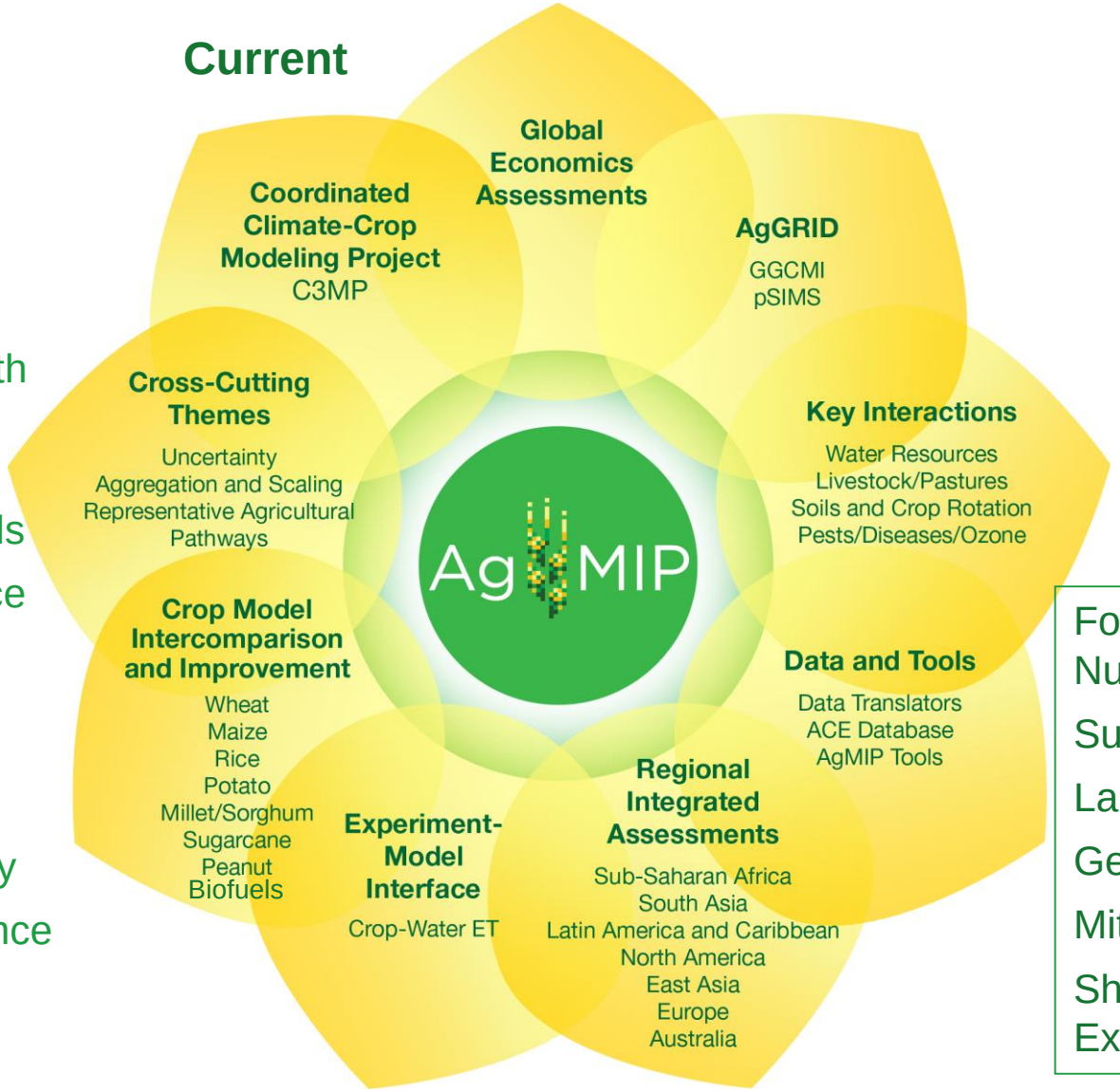
Rosenzweig et al., 2013 AgForMet

AgMIP is an international community of 800+ **climate scientists**, **agronomists**, **economists**, and **IT experts** working to improve models, data, and assessments of sustainable **agricultural systems** and **future food security**

Current and Prospective Activities

Protocols for new AgMIP Teams or Activities:

- Co-Led
- Written plan with short and long-term goals
- AgMIP protocols
- External science advisors
- Review & attribution
- Budget and funding strategy
- Quality assurance



Prospective

- Food Security & Nutrition
- Sustainable Systems
- Land Use
- Gender & Livelihoods
- Mitigation
- Shocks and Extremes

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AgMIP Activity Leaders

(a sampling)

Global Economics	Hermann Lotze-Campen, Keith Wiebe, Dominique van der Mensbrugghe
Rice	Tao Li
Wheat	Senthold Asseng, Pierre Martre, Frank Ewert
Maize	Jean-Louis Durand
Sugarcane	Abraham Singels, Fabio Marin, Matthew Jones, Peter Thorburn
Bioenergy	David LeBauer and Gopal Kakani
Potato	David Fleisher
Livestock	Jean-Francois Soussana and Fiona Ehrhardt
MACSUR/CropM	Reimund Rötter, Frank Ewert, and Martin Koechy/Martin Banse
AgGRID/GGCMI	Christoph Mueller and Joshua Elliott
C3MP	Alex Ruane and Sonali McDermid
Data harmonization/IT	Cheryl Porter and Sander Janssen
FACE-IT	Joshua Elliott and Cheryl Porter
RAPs	Roberto Valdivia and John Antle
Uncertainty	Daniel Wallach, Linda Mearns, Mike Rivington
Crop ET	Ken Boote and Jerry Hatfield
Aggregation and Scaling	Frank Ewert and Lenny van Bussel
Stakeholder Engagement	Amy Solomon and Wendy-Lin Bartels
Water Resources	Jonathan Winter
Soils and Crop Rotation	Bruno Basso
Maize/Millet	KPC Rao and Sibiry Traore
Latin America	Eduardo Assad and Roberto Valdivia
East Asia	Fulu Tao
NextGen	John Antle, Cynthia Rosenzweig, and Jim Jones
Coordinated Global and Regional Assessments	Cynthia Rosenzweig
Maize model improvement	Thijs Tolenaar and Ken Boote

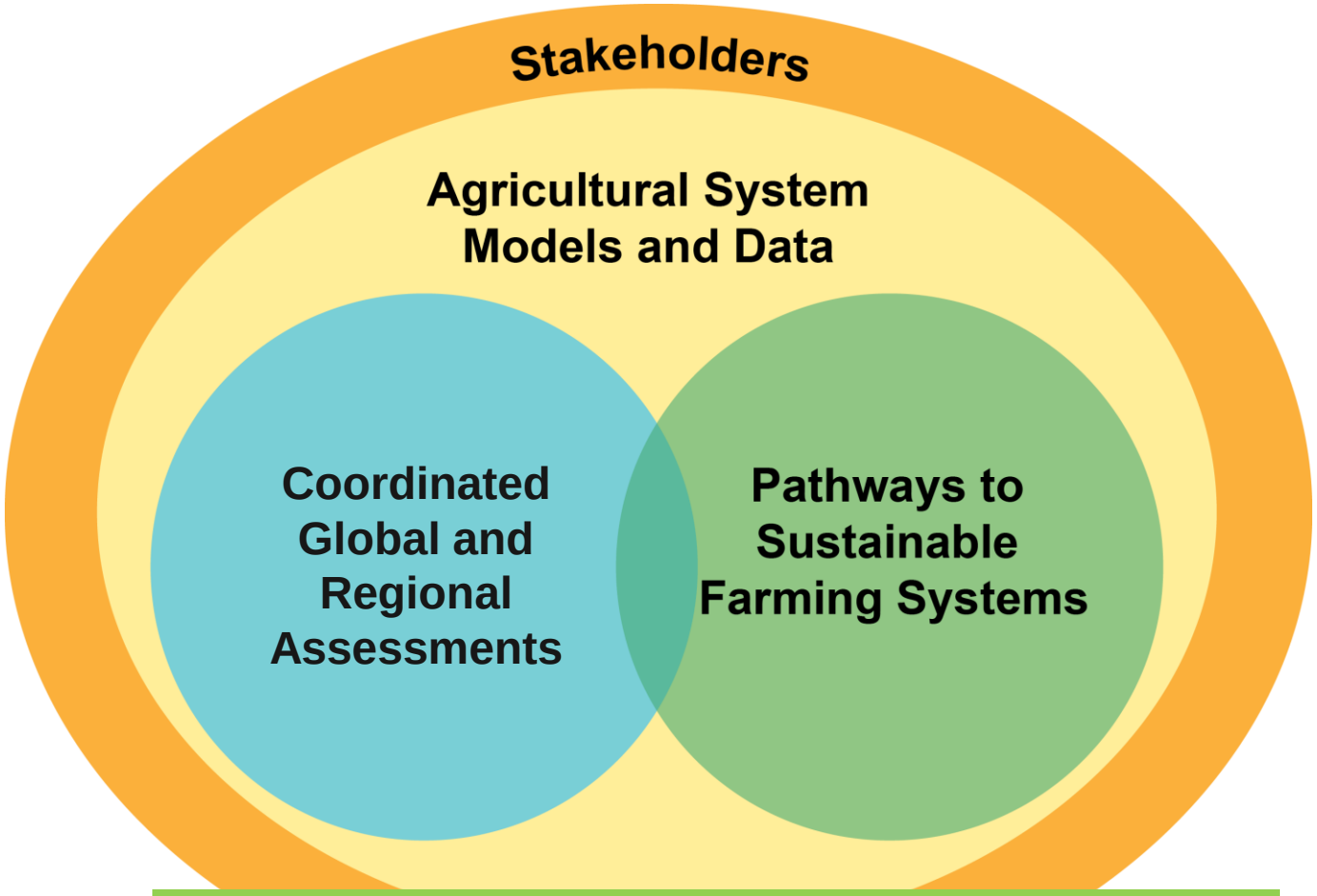
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Donor and Partner Institutions

(a sampling)



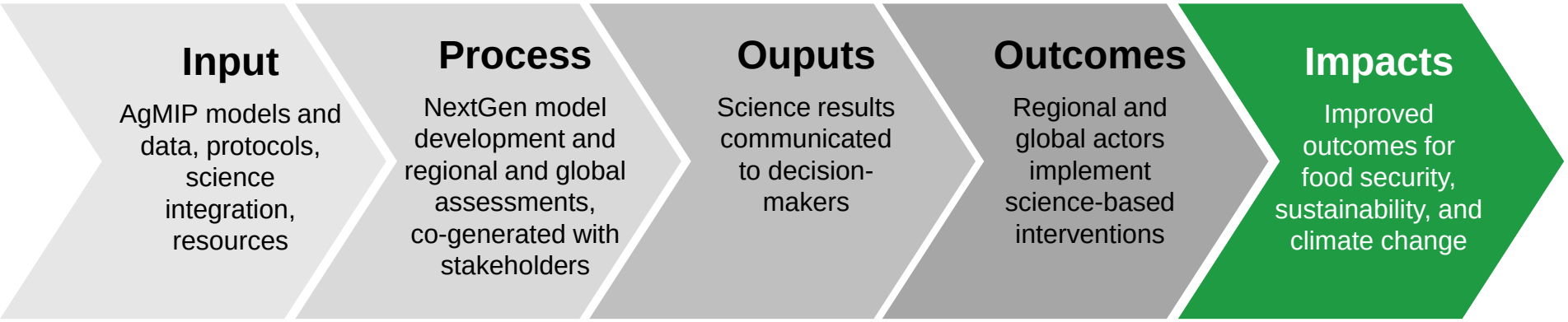
Scope



Knowledge products and tools (e.g., policy briefs, decision support dashboards) usable by stakeholders

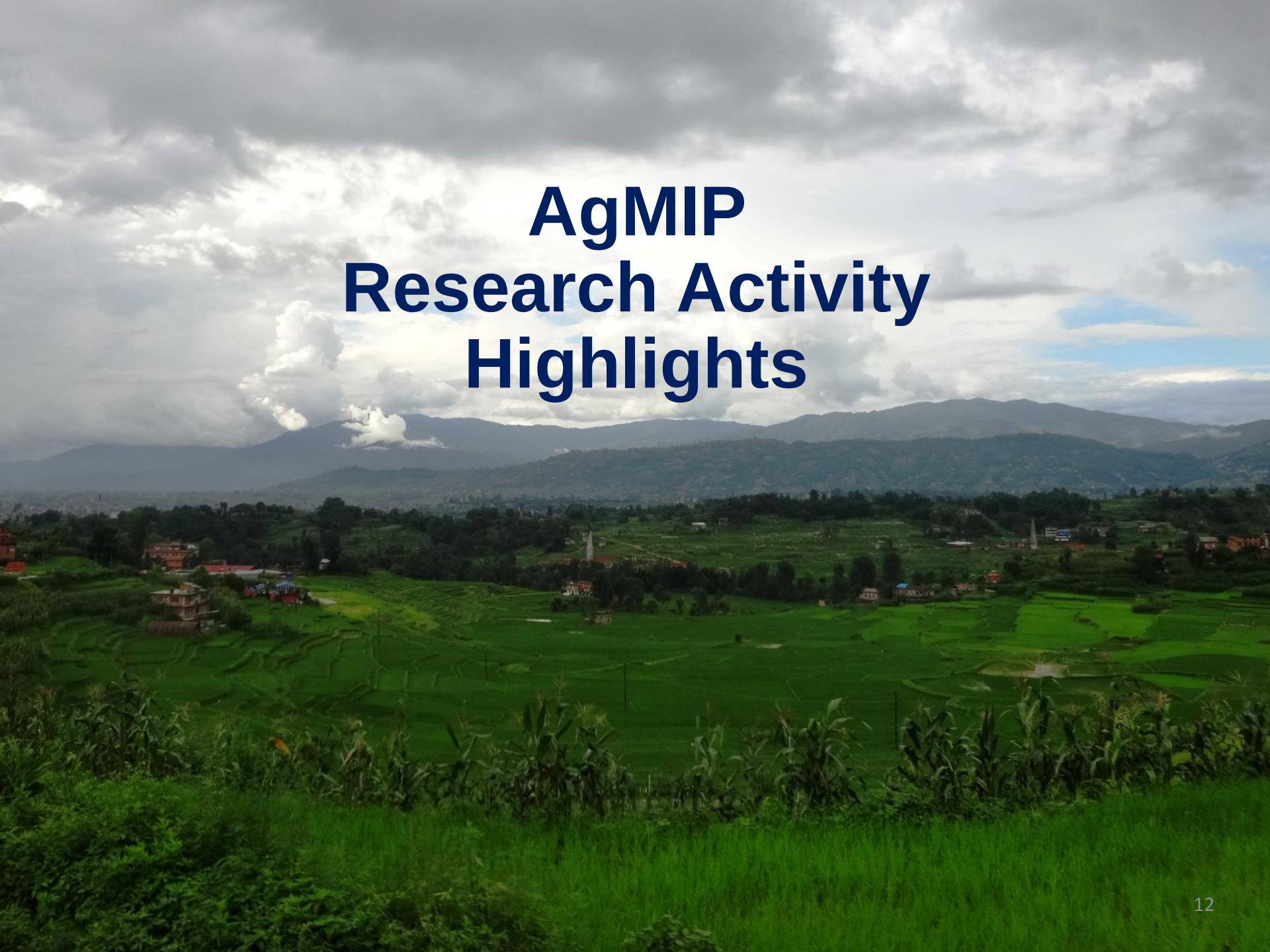
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Steps to Impact



Outputs as public goods, data and knowledge products
Reaching all the way to the farm level and vulnerable populations
Including small-holder farms in the developing world

Stakeholder-scientist co-generated systems research leads to improved capacity, climate risk information, pathways to sustainable agricultural systems, and food security.



AgMIP Research Activity Highlights

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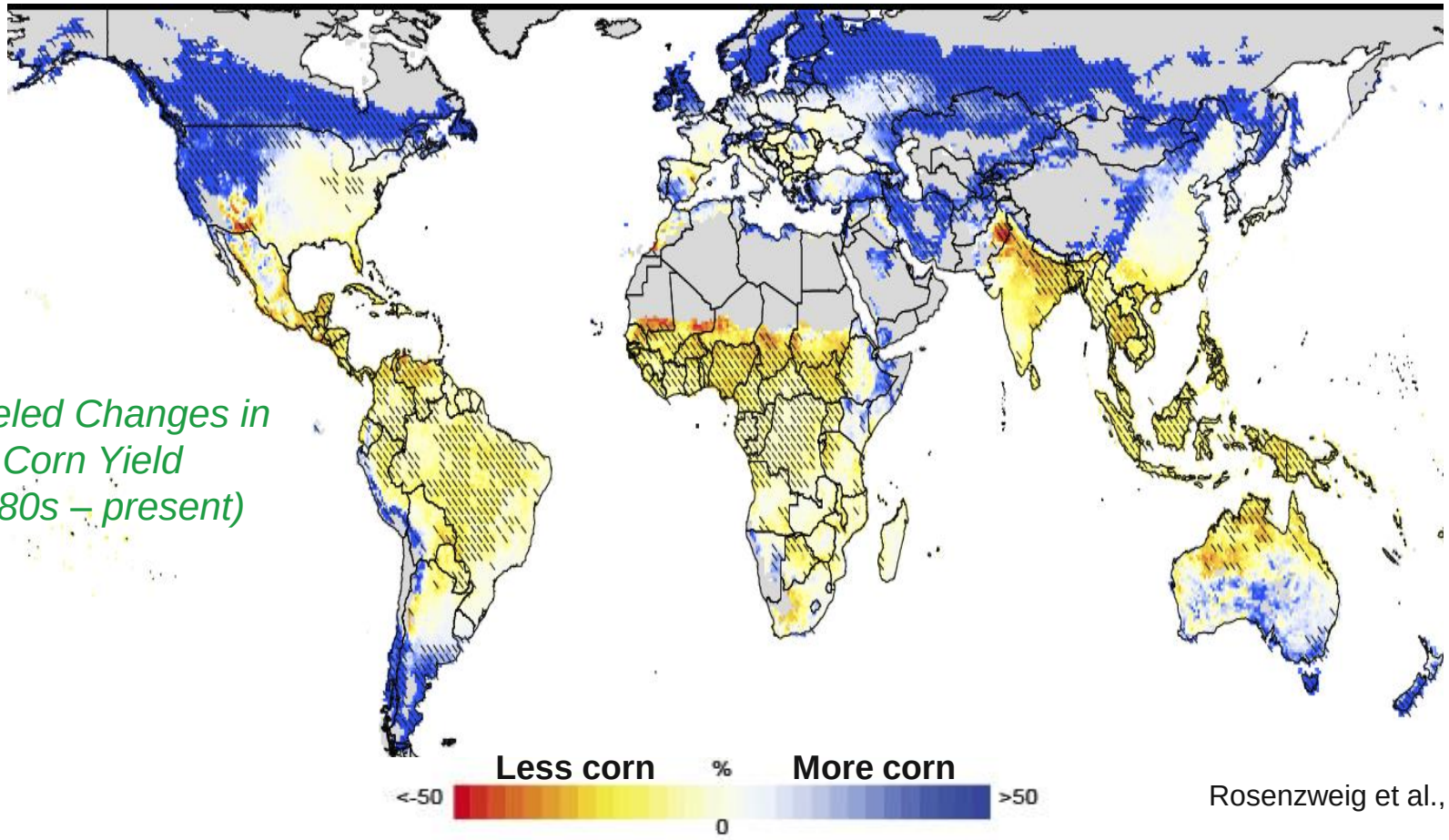
Activities – Crop Modeling

- **Activity 1** – Sensitivity analyses (CO_2, temperature, rainfall, & management; 4 sentinel sites; standardized protocols)
 - Wheat team (Asseng, Ewert, Martre)
 - Maize team (Bassu, Durand, Lizaso, Boote)
 - Rice team (Li, Hasegawa, Zhu, Yin, Boote)
 - Sugarcane team (Singels, Thorburn, Marin)
 - Recent teams: potato (Fleisher, Quiroz), sorghum-millet (----), peanut (Singh)
 - New teams: bioenergy (Kakani/LeBauer), canola (Wang)
 - Soils (Bassu)
- **Activity 2** – Model Improvement (time-series and end-of-season data. Improve code!)

 - Water-ET - Maize Model Impr. - Tcanopy/heat stress - wheat
- **Activity 3** – Evaluate climate-smart adaptations/technology effects

AgMIP/ISI-MIP Global Gridded Crop Model (GGCM) Assessment

Modeled Changes in Corn Yield (2080s – present)



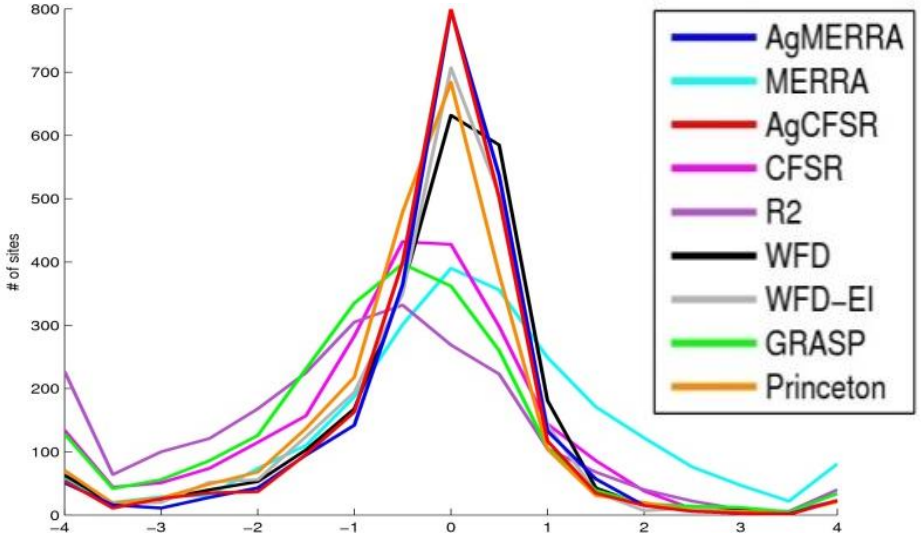
Rosenzweig et al., 2013

GGCMI now includes more than a dozen models
Phase 1: Historical period intercomparison
Phase 2: CTWN-A response

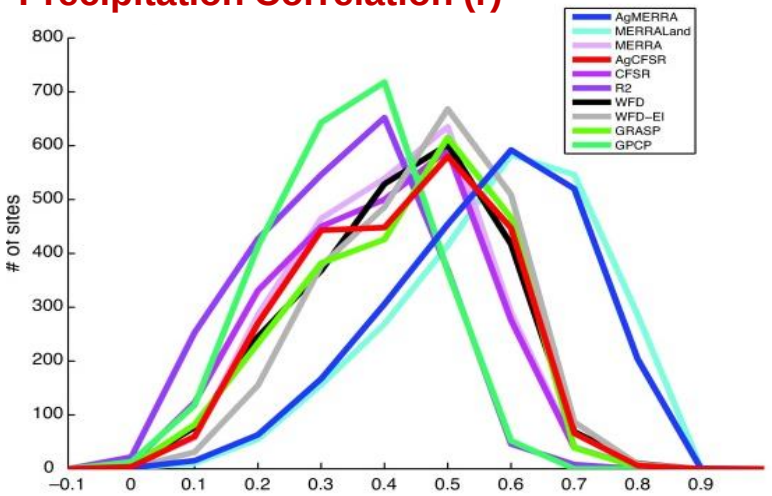
AgMERRA Historical Climate Data

Ruane et al., 2014; Agricultural and Forest Meteorology

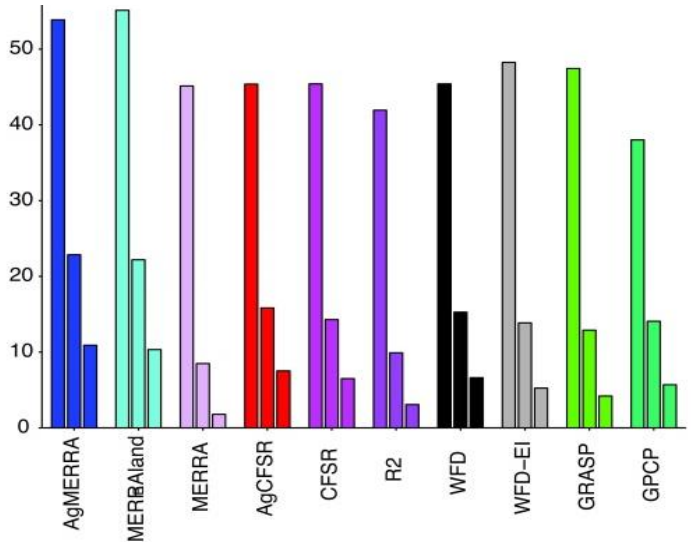
Avg of Tmax and Tmin Biases (°C)



Precipitation Correlation (r)



Threat score for 1, 25, and 50mm precipitation events (%)



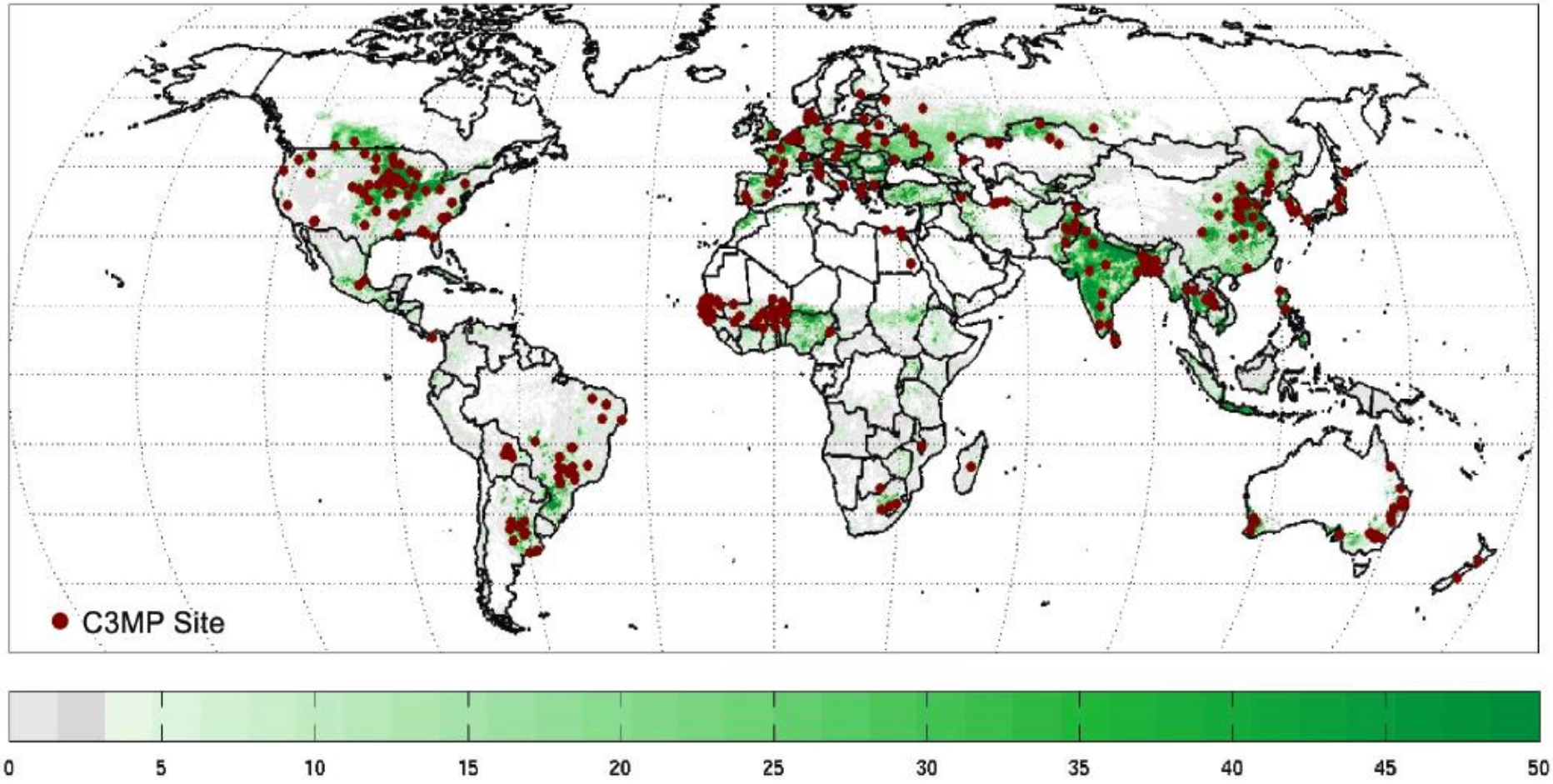
AgMERRA features:

- improved solar radiation
- Improved precipitation variability
- fine spatial patterns of rainfall from satellites
- an adjustment to diurnal temperature range
- relative humidity at Tmax

AgMERRA better captures rainfall distribution and actual sequence of extreme events

Sites included in AgMIP's Coordinated Climate-Crop Modeling Project

All C3MP Submitted Sites and Major Croplands (Percentage Area)



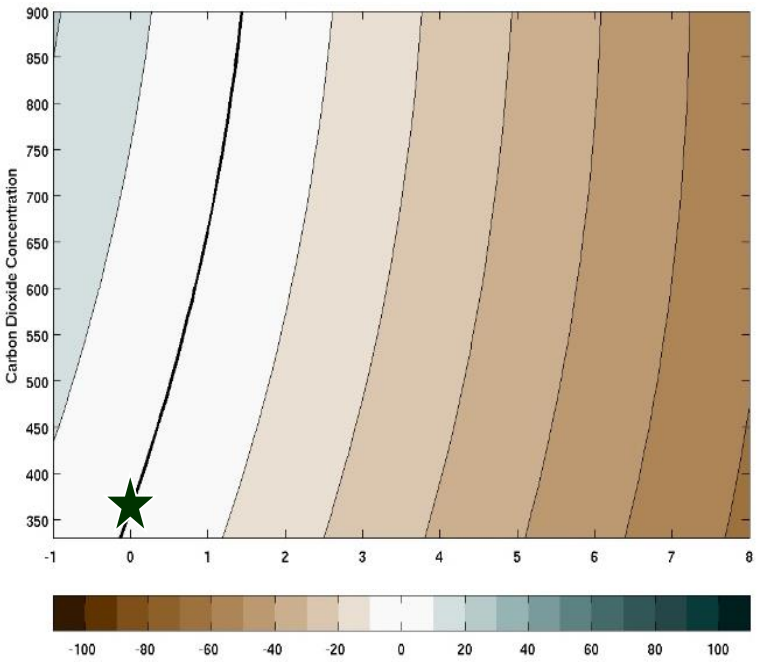
C3MP submitted site (1137 sites as of August, 2015)

Green = fractional crop land area data from Monfreda et al. (2008)

From McDermid et al., 2015

Several approaches to understand uncertainty in crop responses

Mean % Change in Mean Maize Yield (126 Rainfed Maize Sites)



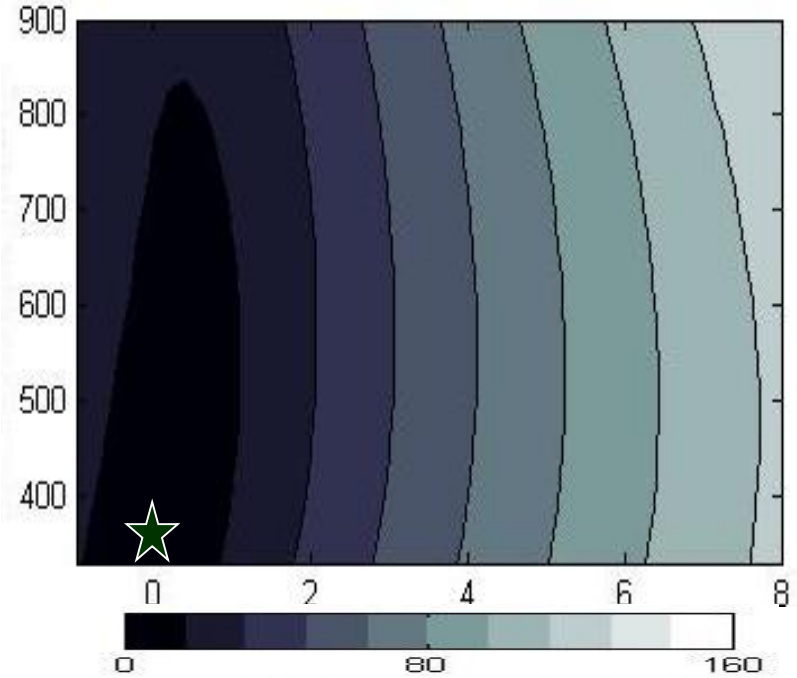
$[CO_2]$

ΔT

$\Delta P = 0\%$ (proxy for climate change)

-100% Yield Change (% of baseline) +100%

Standard Deviation of % Change in Mean Maize Yield



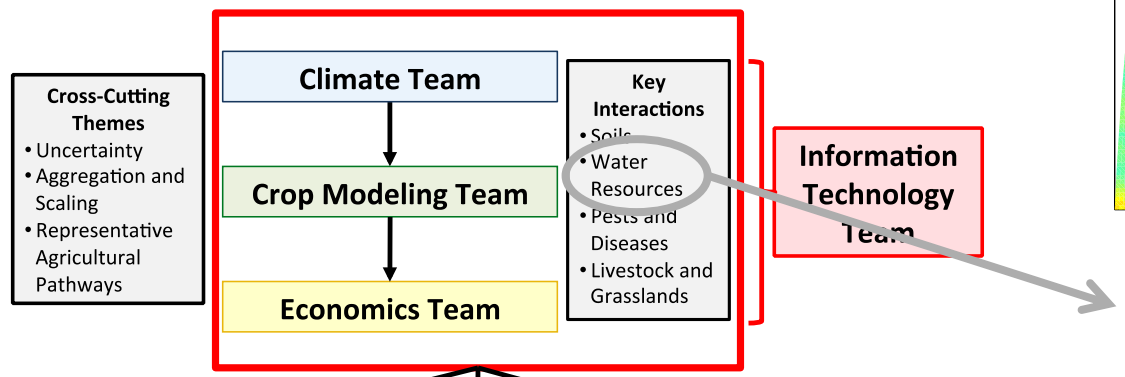
Std. Dev. of Yield Change across sites (% of baseline)

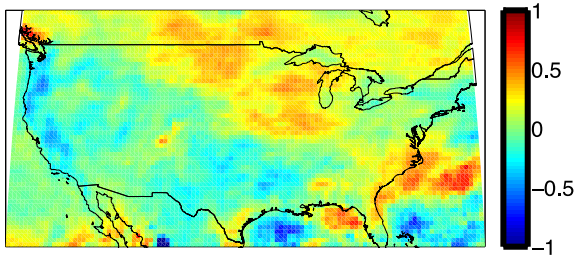
Preliminary results from C3MP; article forthcoming

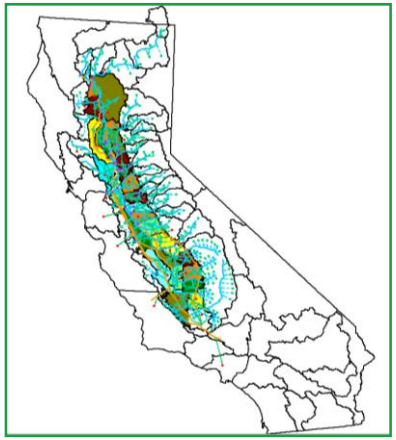
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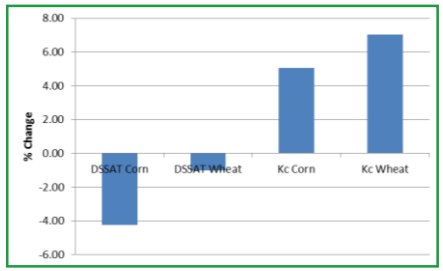
AgMIP Water

Develop projects that assess the effects of climate change and variability on irrigated crops in the United States and throughout the world, as well as build collaborative opportunities to create a portfolio of research at the interface of water and agriculture within the AgMIP framework.







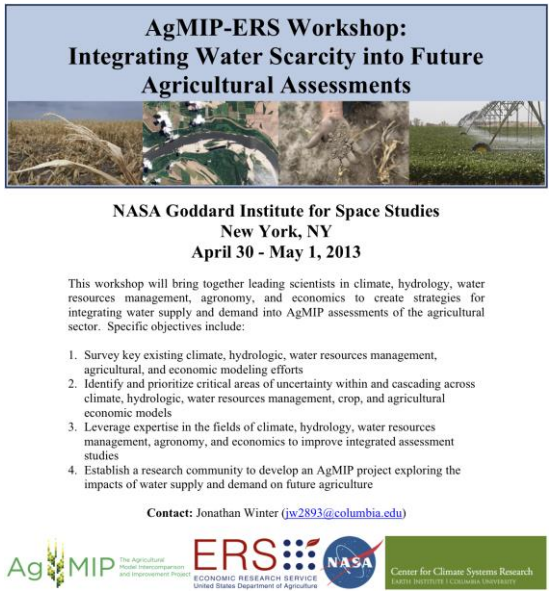


Rosenzweig et al., 2013

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Activities

- Current:
 - NASA-funded AgMIP Water pilot project that links a hydrologic and crop model to simulate irrigated agriculture in California under future climate
 - AgMIP – USDA Economic Research Service Water Workshop, which brought together over 35 scientists to create strategies for improving the representation of water supply and demand in agricultural assessments
 - NIFA-funded Coordinated Agricultural Project (CAP) on Water-, Nutrient-, and Climate-Smart Agriculture
- Future:
 - Postdoctoral researcher (José López Bóbeda) starting in January
 - Global Collaborations – Link to national and international efforts at the water-agriculture nexus
 - More proposals – Continue to pursue funding to build individual projects that explore facets of climate impacts on water resources and agriculture
- Questions, comments, suggestions?
 - jwinter@dartmouth.edu



AgMIP-ERS Workshop:
Integrating Water Scarcity into Future Agricultural Assessments

NASA Goddard Institute for Space Studies
New York, NY
April 30 - May 1, 2013

This workshop will bring together leading scientists in climate, hydrology, water resources management, agronomy, and economics to create strategies for integrating water supply and demand into AgMIP assessments of the agricultural sector. Specific objectives include:

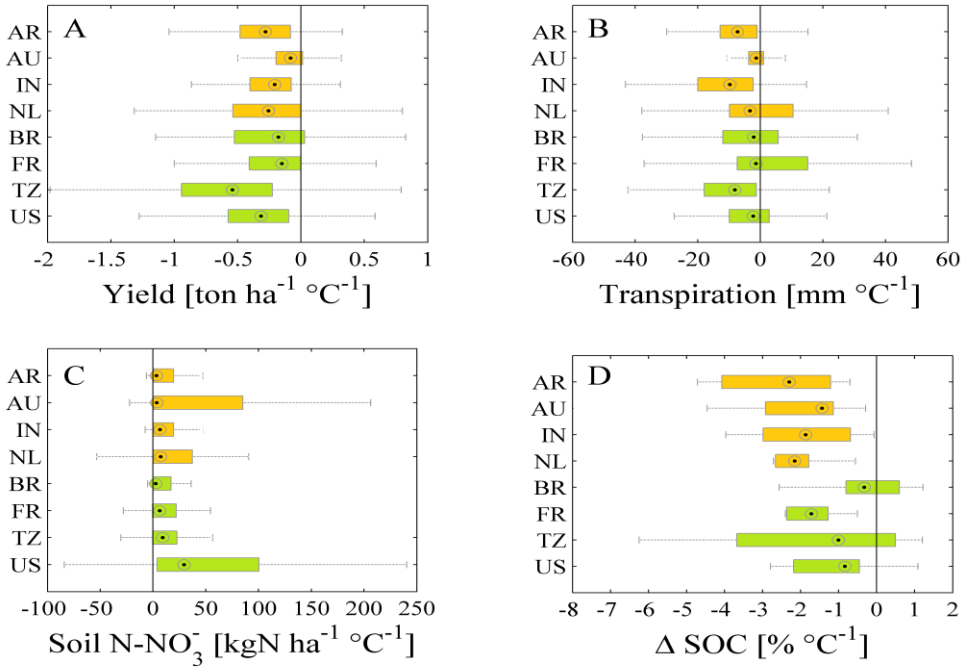
1. Survey key existing climate, hydrologic, water resources management, agricultural, and economic modeling efforts
2. Identify and prioritize critical areas of uncertainty within and cascading across climate, hydrologic, water resources management, crop, and agricultural economic models
3. Leverage expertise in the fields of climate, hydrology, water resources management, agronomy, and economics to improve integrated assessment studies
4. Establish a research community to develop an AgMIP project exploring the impacts of water supply and demand on future agriculture

Contact: Jonathan Winter (jw2893@columbia.edu)

AgMIP ERS ECONOMIC RESEARCH SERVICE United States Department of Agriculture NASA Center for Climate Systems Research

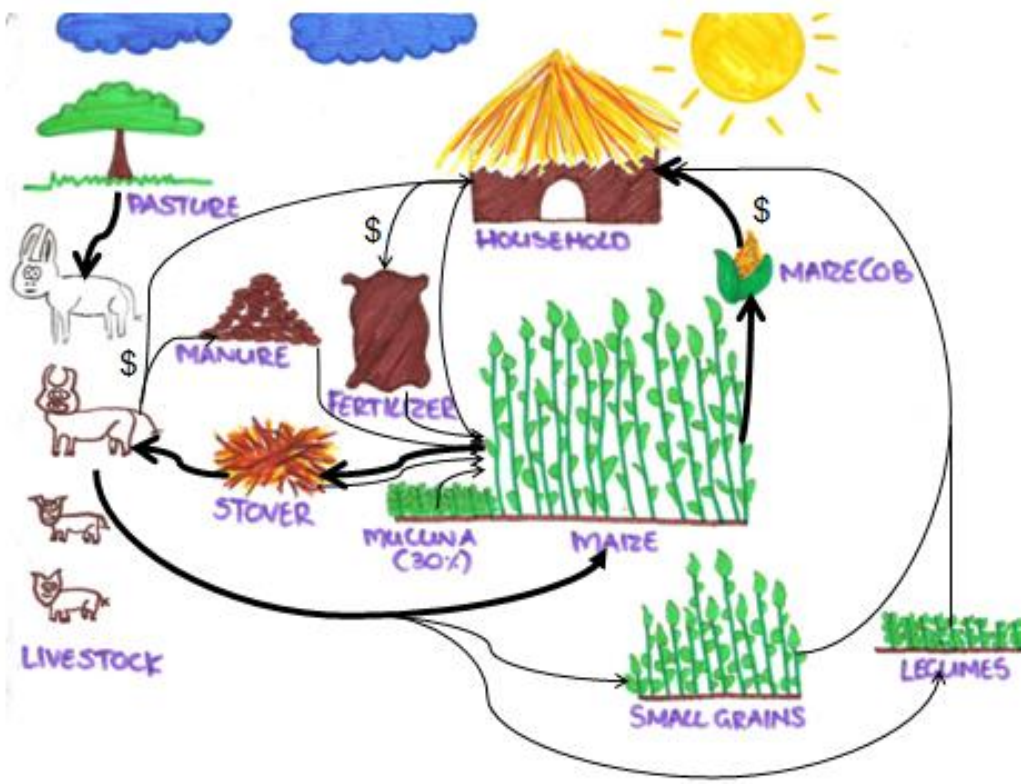
Soil and Crop Rotation

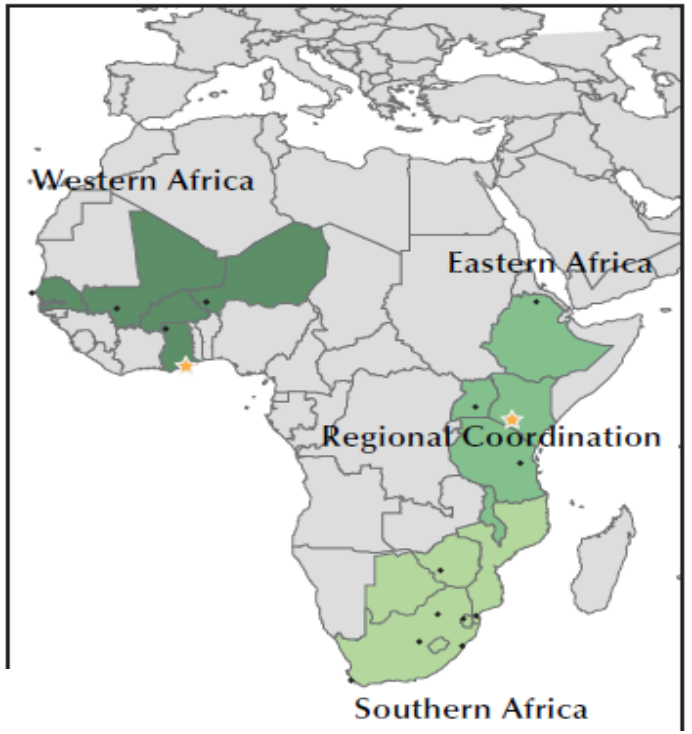
- To assess crop models variability in a long-term maize-fallow and wheat-fallow crop rotation under different management strategies.
- To evaluate the carry-over effects of the interactions between soil, climate and management on yield, and soil carbon, ET.



- With the temperature increase models on average showed:
 - ➢ increase in Soil N-NO_3^-
 - ➢ Decrease in SOC

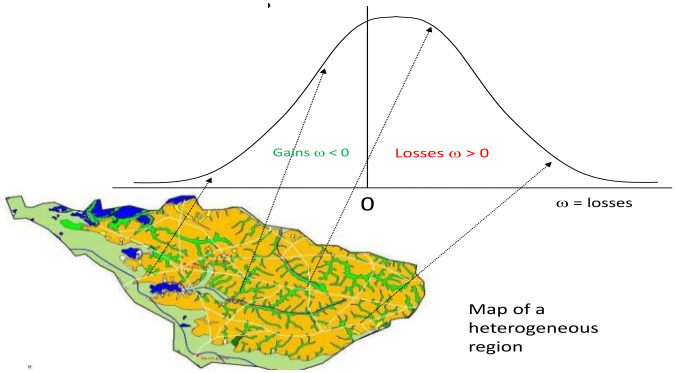
Regional Integrated Assessment for Distributions of Farm Systems





AgMIP-DFID Regional Integrated Assessments:

7 teams across Sub-Saharan Africa and South Asia conducting multi-model integrated assessment of climate impacts, policy choices, and adaptation strategies



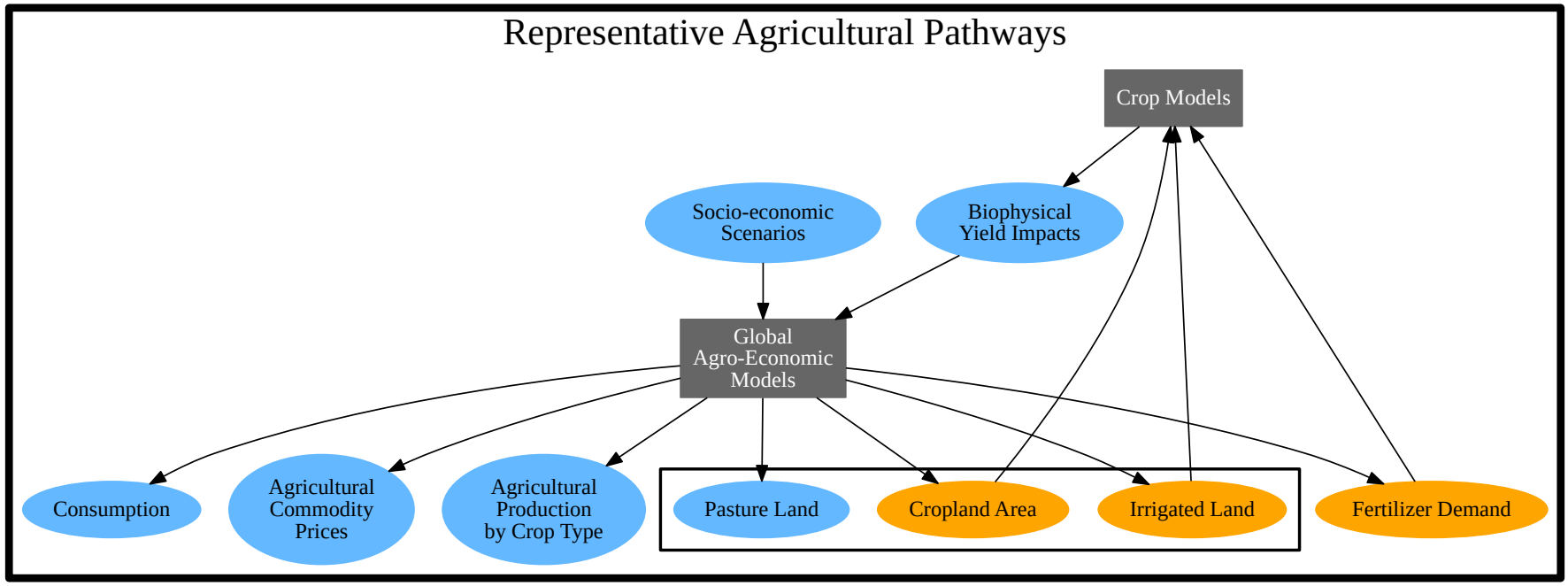
Rosenzweig and Hillel (Eds):*Handbook of Climate Change and Agroecosystems;* Imperial College Press, 2015

Diagram from Masikate et al., 2015

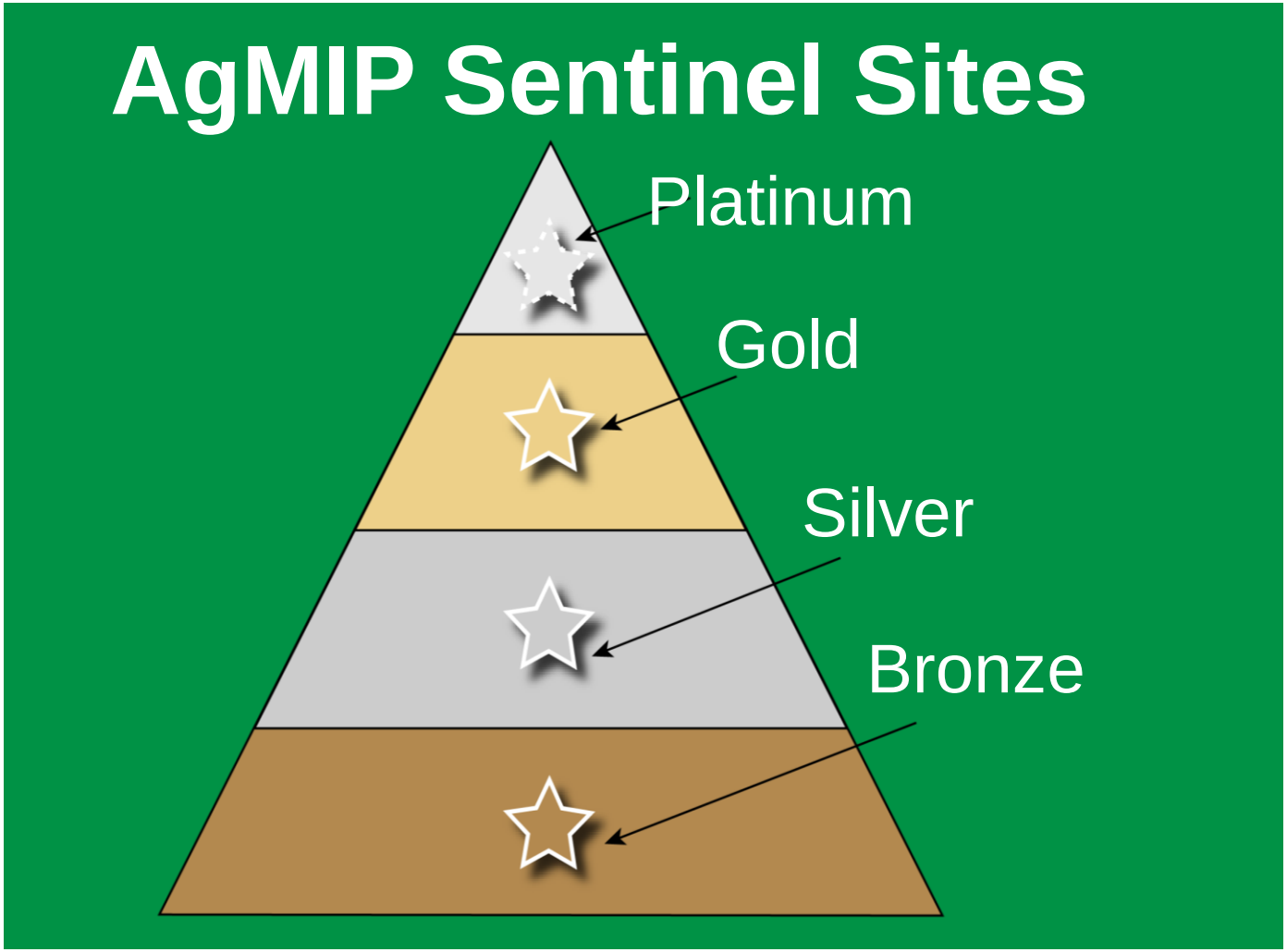
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Global Economics Team

- Objective: multi-decadal simulation of the agricultural sector in the context of changes in broader interacting human/Earth systems
- Current work focuses on constructing “Representative Agricultural Pathways, ensuring consistency between models



AgMIP Data Activities



Boote et al., 2016 (forthcoming)

AgMIP Data

Harmonized Formats
Standards
Ratings
Archives
Climate Datasets

Focus on identifying data and making them more useful for applications

AgMIP Coordinated Global and Regional Assessment



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Major Assessment Questions

***Core Question*: How can we manage risks of and develop resilience to extreme weather, climate change, and other disruptions for agricultural production and food security, now and in the future ?**

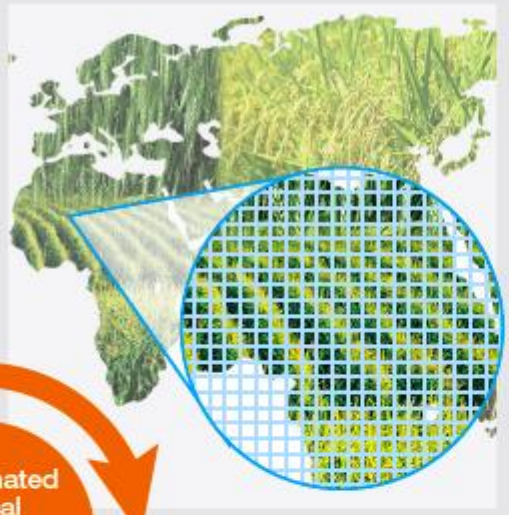
- ***Question #1:*** **What are the capabilities of and limits to adaptation to extreme weather and climate change, now and in the future?**
 - **Key Topics: Technology trends vs specific adaptation strategies; Management; Genetics**
- ***Question #2:*** **What are the effects of agricultural mitigation policies, now and in the future?**
 - **Key Topics: Effects on land use and prices; Biofuels; Soil carbon**
- ***Question #3:*** **How does extreme weather and climate change affect food security/nutrition, now and in the future?**
 - **Key Topics: Availability; Access; Utilization/diet; Stability**
- ***Question #4:*** **How do policies affect agricultural production and food security, now and in the future?**
 - **Key Topics: Trade; Governance; Property rights; Institutions; Water; Land;**

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Building Blocks to allow telescopic scales, feedbacks, and details

Regional research on farming systems using biophysical and socioeconomic models

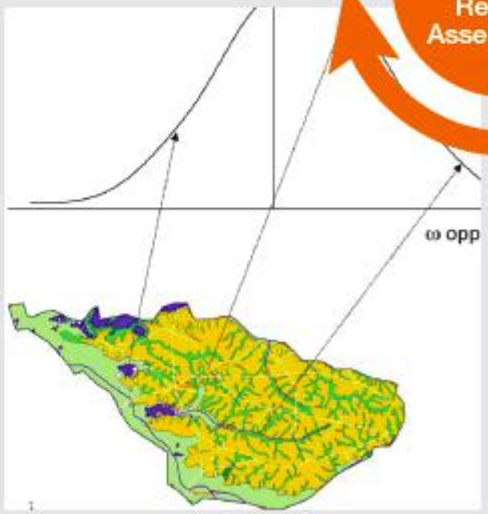


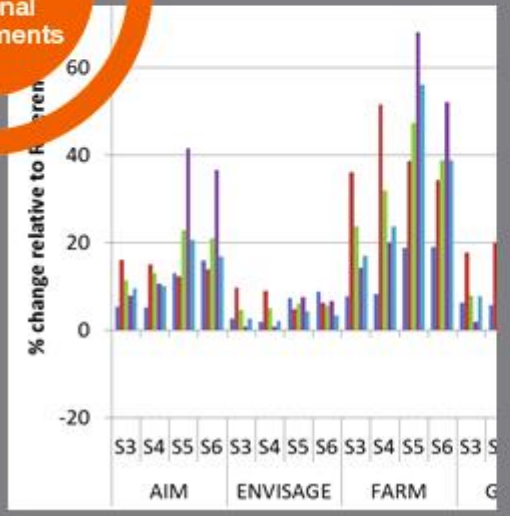


High-resolution gridded crop modeling for gap-filling and aggregation in each region

Coordinated Global and Regional Assessments

Production systems and regional economics to respond to price changes

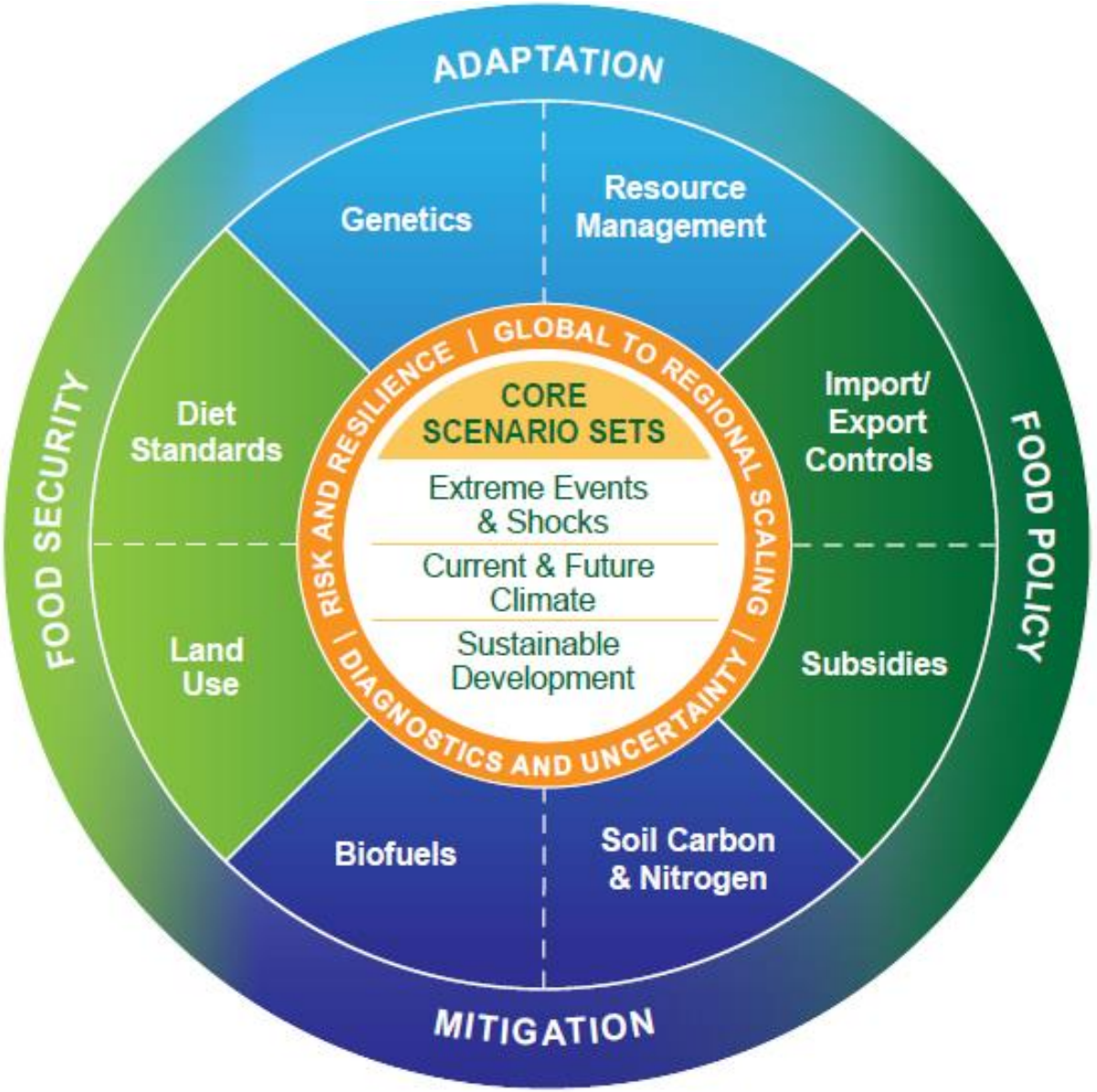




Global economics with analysis of world and regional prices

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CGRA Scenario Sets – Core Risk and Resilience Framing



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Major New Developments in Agricultural Modeling Assessments

- **Disciplinary linkages**: Linked biophysical and economic models
- **Scale linkages**: Consistency from local to global scales
- **Resolution of human outcomes**: Connections to nutrition and health
- **Continuum of time scales**:
 current variability and extremes
 near- and long-term outlooks
- **Scenarios** of adaptation, mitigation, food policy, and food security



Join us!



Upcoming Events

- **iCROPM Workshop**

 Berlin, Germany

 March 14-16, 2016

- **AgMIP6 Global Workshop**

 Montpelier, France,

 June 26-28, 2016



For protocols, up-to-date events and news, and to join AgMIP listserve* – www.agmip.org

*800+ members


Discussion – Questions;
Ideas; Opportunities?

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Principles and Standards

1. Scientific Integrity

AgMIP projects and activities must be based on good science and public-good poducts.

2. Conflict of Interest/Bias

AgMIP Steering Council, Principle Investigators, Team Leaders, and Partner Leads identify possible conflict of interest (NAS) and biases.

Advocacy

AgMIP promotes the best science for development, evaluation, and application of agricultural models

3. Open Data and Models

AgMIP endorses the use and development of open-source/open-access models, data and methods

5. Participation

AgMIP is committed to community building and strives to enable its teams and members in their regions, activities, and funding applications. AgMIP activities are open to all interested researchers and facilitate transdisciplinary integration.

6. Attribution

AgMIP publications attribute all intellectual contributions, including those related to both models and data

7. Flexibility

AgMIP is structured to facilitate the ongoing evolution of agricultural systems science

8. Investment in Future of Systems Research

Encourage new field, younger scientists, uptake of methods to curricula for education

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CGRA Roadmap

Setup: Stakeholder Interactions Throughout!

- Building blocks self-organize
- Regions self-organize
- Science Integration Team determines driving scenarios

- Each region determines a network of representative crop/livestock modeling sites
- Crop/Livestock Teams identify additional sites of interest between regional networks
- Each region determines network of representative regional integrated assessments
- Climate team provides climate scenarios for each site/grid

- Regional experts work with global modelers to improve parameters

Execution:

- Crop/livestock modeling sites run by multiple models
- Global gridded models run
- Results compared and hybrid product created

- Global economic models run with hybrid crop/livestock drivers
- Reginal economic models run RIAs with global economic model prices
- Food security models and metrics created

- Results provided to central, public-facing database

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Timeline

~2020: IPCC AR6 published

2019: CGRA research published

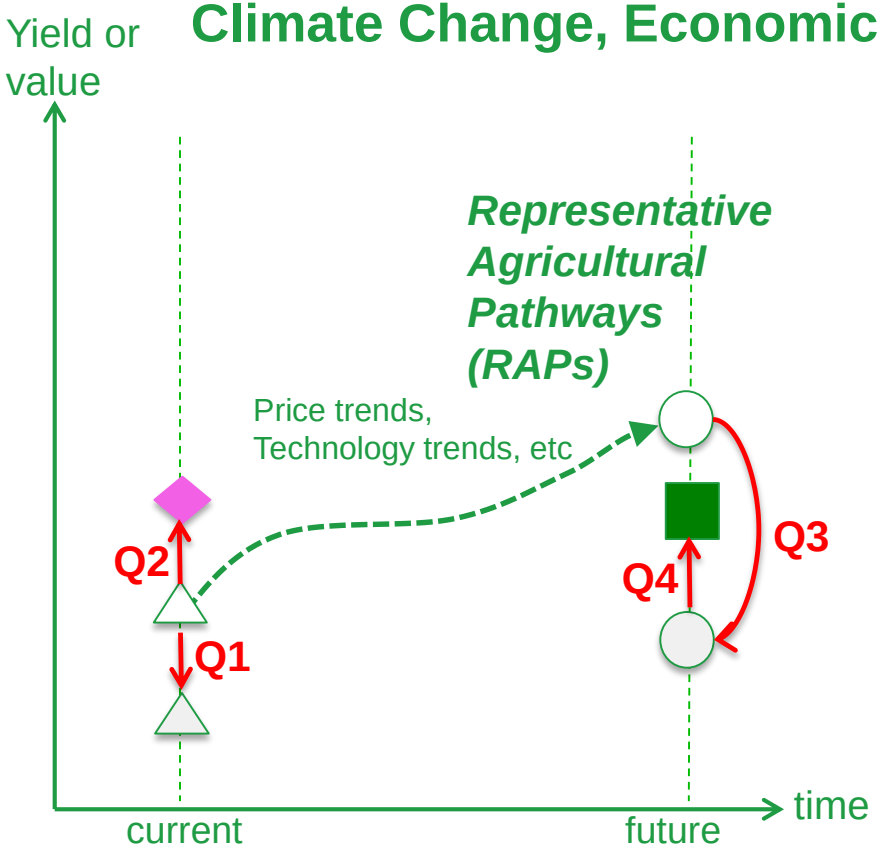
2018: CGRA conducted

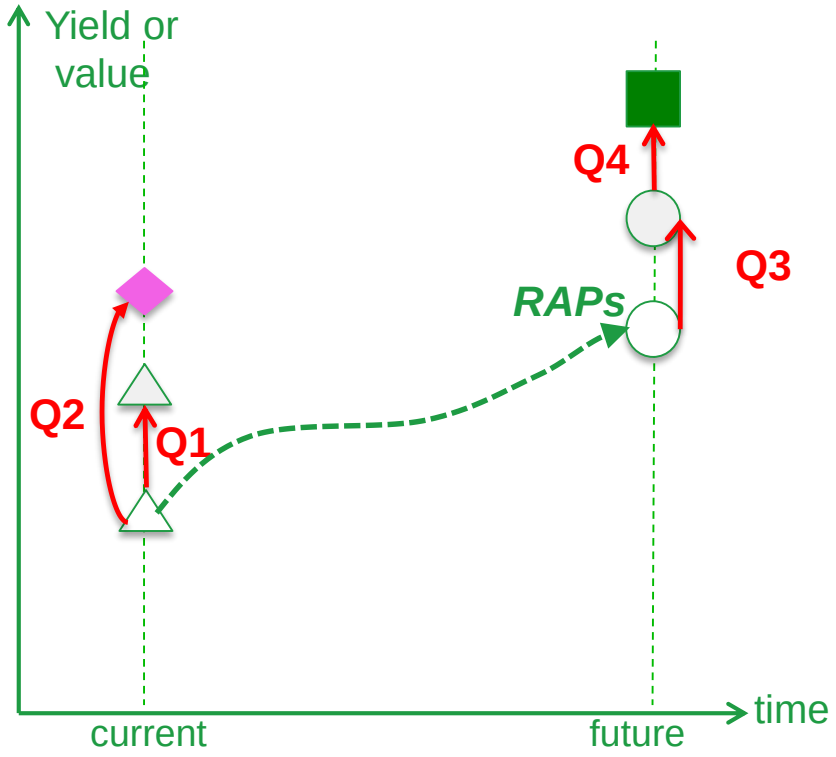
2017: Protocols finalized and CGRA begins

2016: Pilot projects for connections and protocols

2015: CGRA launch and coalition-building

AgMIP Core Research Questions:
Climate Change, Economic Development, and Adaptation





Q1: What is the sensitivity of current agricultural production systems to climate change? This question addresses the isolated impacts of climate changes assuming that the production system does not change from its current state.

Q2: What are the benefits of adaptation in current agricultural systems? This question addresses the benefit (e.g., economic and food security resilience) of potential adaptation options to current agricultural systems given current climate

Q3: What is the impact of climate change on future agricultural production systems? Assessment of climate impacts on the future production system, which will differ from the current production system due to development in the agricultural sector

Q4: What are the benefits of climate change adaptations? Assessment of the benefits of potential adaptation options in the future production system

AgMIP Regional Research Teams RAPs Trends Table: SSA (AgMIP, Phase I)

Variable	CLIP – R1 Zimb	CLIP – R2 Zimb	CLIP – R1 Mozamb	CLIP – R2 Mozamb	East Africa Embu, KE	West Africa R1 Nioro	West Africa R2 Nioro	SAAMIP South Africa	SAAMIP Namibia
Soil degradation	↘	↗	↗	→	↗	↗	↘	↗	↗
Pest and diseases	⬣	⬣	⬣	⬣	→	⬣	⬣	⬣	⬣
Extreme events	↗	↗	⬣	⬣	↗	⬣	⬣	⬣	⬣
Water availability	⬣	⬣	⬣	⬣	↘	⬣	⬣	↘	↘
Farm size	↘	↘	→	→	↘	↗	↗	↗	↘
Household size	↗	→	→	→	↗	↘	↘	⬣	↘
Herd size	↗	↘	→	↗	⬣	↗	↘	⬣	⬣
Livestock Productivity	↗	↘	→	↗	⬣	↗	↗	⬣	⬣
Fertilizer prices	→	↗	↘	↘	↗	→	→	⬣	⬣
Fertilizer use	↗	↘	↘	↗	↗	⬣	⬣	↗	↗
Subsidies (inputs)	↗	→	→	→	⬣	→	↘	⬣	⬣
Off-farm income	↘	↘	↗	↗	↗	↗	↗	↗	↘
Improved crop use	↗	↘	→	↗	⬣	↗	↗	↗	→
Information availability	⬣	⬣	⬣	⬣	↗	⬣	⬣	⬣	⬣
Public invest in Agriculture	↗	→	↘	↗	⬣	⬣	⬣	↗	→
Labor availability	→	↘	↗	↗	↘	⬣	⬣	⬣	⬣

Direction and magnitude	
No change	→
Small increase	↗
Moderate increase	↗
Large increase	↗
Small decrease	→
Moderate decrease	↘
Large decrease	↘
Not included in RAP or under revision	⬣

BAU Pessimistic

SSP2, period 2050